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Do individuals with autism spectrum disorder process own- and other-race faces differently?

Li Yi [a,*], Paul C. Quinn [b], Cong Feng [c,d], Jiao Li [a], Haiyan Ding [e], Kang Lee [f,g,*]

[a] Department of Psychology, Sun Yat-sen University, China
[b] Department of Psychological and Brain Sciences, University of Delaware, USA
[c] Department of Philosophy, Sun Yat-sen University, China
[d] Institute of Logic and Cognition, Sun Yat-sen University, China
[e] Guangzhou Zhanneng Vocational Training Center for the Disabled, China
[f] Dr. Eric Jackman Institute of Child Study, University of Toronto, Ontario, Canada
[g] School of Education, Zhejiang Normal University, China

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ABSTRACT

Individuals with autism spectrum disorder (ASD) process human faces in atypical ways according to previous literature. We investigated whether individuals with ASD can process face race information and respond to own- and other-race faces differentially. Chinese individuals with ASD ($n = 24$), typically developing (TD) individuals ($n = 28$), and individuals with intellectual disabilities (ID, $n = 26$) were asked to recognize Chinese and Caucasian faces in an old-new face paradigm using eye tracking. In terms of recognition, the ASD and ID groups did not perform differently and displayed superior own-race recognition compared with other-race faces; TD participants displayed similar recognition of the two types of faces. In terms of eye tracking, the TD, ASD, and ID groups displayed more looking on the eyes and less looking on the nose and mouth of Caucasian faces relative to Chinese faces. Overall, individuals with ASD manifested a behavioral other-race effect and displayed the same type of cross-racial differentiation in face scanning observed in TD individuals. The findings suggest that as is the case with TD individuals, face processing of individuals with ASD is influenced by differences in visual experience with different face categories.

1. Introduction

Individuals with autism spectrum disorder (ASD) have difficulty in recognizing and discriminating human faces, compared to typical populations in previous studies (e.g., Gepner, de Gelder, & de Schonen, 1996; Klin et al., 1999). However, these prior studies on face processing in ASD mostly used human faces from the same racial group as the participants. In particular, Caucasian facial stimuli were used for Caucasian participants. Using eye-tracking methodology, we investigated whether individuals with ASD process faces of other racial groups differently from faces of their own racial group so as to elucidate the role of visual experience in face processing of individuals with ASD.

In addition to the study of behavioral performance of face processing by those with ASD, eye-tracking techniques have allowed researchers to examine eye movement patterns of individuals with ASD when they view faces. However, controversies exist with regard to previous findings on face scanning patterns in ASD. A number of prior eye-tracking studies have reported that compared to typically developing (TD) people, individuals with ASD attended less to human faces and core facial features, especially the eye region (e.g., Klin & Jones, 2008; Klin et al., 2002a; Klin et al., 2002b; Pelphrey et al., 2002; Shimojo, Wu, & Shimojo, 2013; Trepagnier, Sebrechts, & Peterson, 2002; Yi et al., 2013). However, other studies reported similar face scanning patterns in TD individuals and those with ASD (Falck-Ytter et al., 2010; Rutherford & Towns, 2008). As was the case with behavioral recognition and discrimination, all the eye-tracking studies mentioned above focused only on human faces of the same race as the participants.

Examining how individuals with ASD process faces of other racial groups would deepen our knowledge of the nature of face processing abnormalities in ASD. The current study investigated whether individuals with ASD process faces of other racial groups

* Corresponding authors at: Department of Psychology, Sun Yat-sen University, 135 Xingang West Road, Guangzhou 510275, China (L. Yi). Dr. Eric Jackman Institute of Child Study, University of Toronto, 45 Walmer Road, Toronto, Ontario, Canada (K. Lee).
E-mail addresses: yili5@mail.sysu.edu.cn (L. Yi), kang.lee@utoronto.ca (K. Lee).

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differently from faces of their own racial group with the specific goal of elucidating the role of visual experience with human faces in ASD. One hypothesis proposed fundamental deficits that are specific to processing faces in ASD (e.g., see, for example, discussion in Chawarska & Volkmar, 2007). If there is a pervasive face processing deficit associated with ASD, then it should mute individuals with ASD to all aspects of visual experience. However, if some aspects of face processing are spared and are normal in ASD (e.g., Cleary et al., 2014), then ASD individuals should be sensitive to those aspects. Race is a salient social category attribute of faces, and there is compelling evidence that typically developing individuals display differences in processing same- vs. other-race faces based on differential experience (Anzures et al., 2013a; Anzures et al., 2013b). If there is an all-encompassing face processing deficit in ASD, then ASD individuals would be expected to process same- and other-race faces similarly. However, if processing of race information is spared in ASD, then we would expect that ASD individuals are sufficiently sensitive to experiential differences between same- and other-race faces to display cross-racial face processing differences.

It is well established that typically developing individuals display an advantage in recognizing and discriminating own-race faces over other-race ones (e.g., Walker & Tanaka, 2003; see Meissner & Brigham, 2001, for a review). This other-race effect (ORE), consistently found in the typical population across ages and races (Lee et al., 2011), could be due to a number of not mutually exclusive factors, such as one's extensive experience with own-race faces and relatively limited experience with other-race faces, incorporation of culture-specific cognitive processes (e.g., Fu et al., 2012; Hu et al., 2014; Liu et al., 2011), and even explicit or implicit racial prejudice (Lebrecht et al., 2009; Zebrowitz, White, & Wieneke, 2008).

We sought to investigate whether those with ASD are sensitive to the cross-racial difference in visual experience with faces. To date, how individuals with ASD process own- and other-race faces has only been explored in two studies. Wilson and colleagues (2011) asked children with ASD and TD children to choose from two alternative faces to match the identity of a target face, and found that both ASD and TD groups displayed a typical own-race advantage in this task. The Wilson et al. (2011) results are consistent with the findings that 6-year-old children with ASD display the same type of gender and racial stereotyping as unimpaired controls (Hirschfeld et al., 2007). Given that the children with ASD failed a false-belief task, the combination of findings has been used to argue that while those with ASD display theory-of-mind deficits (e.g., Baron-Cohen, Leslie, & Frith, 1985), they may process observable social category attributes such as gender and race in ways comparable to typically developing individuals (Hirschfeld, 2013). However, in a more recent study by Chien et al. (2014), only TD children, but not children with ASD, displayed an own-race advantage over other-race faces. This latter result thus suggests that children with ASD are not sensitive to race information in faces.

Considering the inconsistency in the existing evidence regarding the behavioral ORE in individuals with ASD, we investigated their face scanning patterns to provide a different measure of processing race information from faces. That is, by using eye tracking, we examined whether individuals with ASD, as well as their age-matched TD peers and IQ-matched peers with intellectual disabilities (ID), display different cross-racial face scanning patterns. We also tested face recognition of these three groups. It is noteworthy that a majority of the participants in the Wilson et al. (2011) study were Caucasian, whereas the participants in the current study are Chinese. The involvement of Chinese participants with ASD thus allows us to assess whether the perception of face race in individuals with ASD is impacted by racial identities different from Caucasian.

We used an old-new face recognition paradigm to ask Chinese participants to remember several face identities (half of the faces were Chinese and the other half were Caucasian) and then tested whether participants perceived the faces as "old" or "new". In addition, we provided a longer viewing time than what is typical in a face recognition study in order to obtain sufficient eye-tracking data. Due to these procedural changes, we anticipated that TD individuals would reach ceiling in their recognition performance for both races of faces because the task would be rather easy for them. Thus, we did not expect to find the own-race face superiority effect seen among the TD individuals in a typical face recognition paradigm. However, the current task might not be too easy for individuals with ASD such that their recognition performance might be above the chance level, but below ceiling. If that were the case, based on the findings of Wilson and colleagues (2011), we expected a recognition advantage for own-race faces over other-race ones in individuals with ASD.

We also used area of interest (AOI) and data-driven data analytic methods to examine whether individuals with ASD display different cross-racial face scanning patterns when compared with TD and ID groups. We expected that participants with ASD would fixate on core facial features (e.g., eye region, nose, and mouth) differently from TD and ID groups, based on previous evidence regarding ASD-related face processing abnormalities.

With regard to own- and other-race face scanning differences, cultural differences in eye gaze patterns when processing faces have been found in the prior literature with typical populations (e.g., Fu et al., 2012; Wheeler et al., 2011). More specifically, it has been suggested that Chinese individuals have been socialized to focus on the central regions of faces (e.g., the nose region) whereas Westerners have been socialized to focus on the eye regions (Fu et al., 2012). This nose-centric strategy seen among Chinese individuals has been further suggested to be due to the fact that Chinese cultural norms of face-to-face interaction discourage excessive eye contact. There is, however, controversy as to whether Chinese observers show the nose-centric scanning pattern for Chinese faces only (Fu et al., 2012; Hu et al., 2014) or for both own- and other-race faces (e.g., Blais et al., 2008; Kelly et al., 2011). Regardless of this controversy, it is agreed that socialization of cultural norms regulating interpersonal interaction drives the scanning of faces by TD individuals. Although no study has examined whether individuals with ASD would show different eye movement patterns when processing own- and other-race faces, based on the existing findings with Chinese adults and infants (Fu et al., 2012; Hu et al., 2014; Wheeler et al., 2011), we expected that our Chinese TD individuals would scan the eye regions of Caucasian faces longer than those of Chinese faces, but scan the nasal and oral regions of Chinese faces longer than those of Caucasian faces. We also hypothesized a similar cross-racial differentiation of face scanning patterns in individuals with ASD. However, given impairments in social communicative skills in ASD, we speculated that the influence of socialization of cultural norms, if any existed, would have a lesser impact on individuals with ASD than TD individuals, and thus cross-racial differences of face scanning patterns in ASD individuals might be smaller relative to TD individuals.

2. Material and methods

2.1. Participants

We recruited three groups of participants: 24 adolescents and young adults with ASD and 26 individuals with ID as IQ-matched peers recruited from special training centers for the disabled in Guangzhou, China, and 28 age-matched TD individuals in the same city also participated (see Table 1 for detailed information on the participants). Both ASD and ID participants were previously diagnosed by professional clinicians according to the DSM-IV (American Psychiatric Association, 1994). The diagnosis of ASD was further confirmed by the Gilliam Autism Rating Scale (GARS-2; Gilliam, 2006). The ASD group was matched with the TD group by chronological age, and with the ID group based on the IQ scores from the Combined Raven Test (CRT). The study was conducted under The Code of Ethics of the World Medical Association (Declaration of Helsinki). We also obtained informed consent from the participants or their parents (if the participants were younger than 18 years of age) before the experiment.

2.2. Stimuli and procedure

The study used 74 images of human faces (500 × 700 pixels), including 18 Chinese male faces, 19 Chinese female faces, 19 Caucasian male faces, and 18 Caucasian female faces. All faces were displayed in frontal view with hair removed using an elliptical shape frame. The faces were also rendered gray to match in brightness and luminance (see Fig. 1a as an example).

Participants were seated 60 cm from the display screen. A calibration procedure was performed before the formal experiment. Participants passed the in-built Tobii Calibration procedure when both eyes achieved good mapping on all five test positions. In the following experiment, each participant completed one block of familiarization and five blocks of formal test (as shown in Fig. 1b). In the familiarization block, participants viewed and remembered 12 study faces (balanced in race and gender) and 2 block faces. In order to prevent primacy and recency effects, we placed the 2 block faces (one Chinese female and one Caucasian male) in the first and last trial of the study phase and they were never shown in the test phases. All pictures were presented for 3 s. In the following five test blocks, participants were asked to recognize the faces they just saw in the familiarization block by judging whether each face was a familiar face ("seen", press a key) or a novel face ("never seen", not respond). There were 36 faces in each test block (balanced in race and gender), including 12 target faces, 12 additional review faces which were the same as the study faces viewed in the familiarization phase, and 12 foil faces (balanced in race and gender) which had not been previously seen. The 12 target-review faces were the same for all five test blocks, and the 12 foil faces were different for each test block. The order of presentation of the faces was randomized, with each trial followed by feedback, as shown in Fig. 1b. Review faces, which were the same as the target faces, were presented for 3 s after the target faces were responded to, and the target and foil faces were presented until the participant responded. Experimenters observed and recorded participant responses on the recording sheets. Eye movements were recorded at a sampling rate of 60 Hz for each eye with a Tobii T120 eye tracker.

2.3. Data analysis

Five AOIs were defined for each face picture: the whole face, the left eye (from the observer's view), the right eye, the nose, and the mouth (see Fig. 1a for examples). We defined AOIs as areas corresponding with each feature plus 50 pixels beyond its contour. Fixations with less than 100 ms of duration were excluded from analysis, and we summed durations within each AOI to calculate total fixation durations. We excluded total fixation durations that were 3 *SDs* beyond the mean of their respective AOI (1.49% of the data). Proportional fixation durations were computed by dividing total fixation durations within each AOI by total fixation durations on the whole face. All fixations on target and foil faces during all blocks (familiarization and test) were combined for the subsequent data analysis due to their high homogeneity in the preliminary analysis.

To better illustrate the scan patterns for each group and each condition and their respective differences, we created heat maps for fixation durations for each condition as well as their differences using the i*Map* toolbox developed by Caldara and Miellet (2011). Rather than employing the predefined subjective segmentation of visual stimuli (i.e., AOIs), the i*Map* toolbox computes the statistical maps of fixations on any location in a visual stimulus to assess significant fixation spots within and between experimental conditions. It also generates 3D fixation heat maps for visualization.

Lastly, to investigate whether the eye movements during the task would predict face recognition accuracy, we conducted correlational analysis between behavioral performance (i.e., recognition accuracy) and eye movement patterns.

3. Results

3.1. Accuracy

Accuracies (%) of all groups to recognize own- and other-race faces, as listed in Table 2, were first compared to the chance level of 50% using one-sample t tests, and then compared between groups and races using a 2 (Race: own vs. other) × 3 (Group: ASD vs. ID vs. TD) mixed-design ANOVA. Results showed that recognition accuracies of TD and ID groups for both races of faces were significantly above chance ($ps < .05$). Recognition accuracies of the ASD group for Chinese faces were significantly above chance ($t(23) = 2.29$, $p = 0.032$), but recognition accuracies of the ASD group for Caucasian faces did not differ from chance ($t(23) = -0.11$, $p = 0.91$). The two-way ANOVA yielded a significant effect of participant group ($F(2, 75) = 191.23$, $p < 0.001$, $\eta^2 = 0.84$). A priori contrasts found that the group effect took the form of individuals with ASD responding less accurately than TD individuals ($p < 0.001$), but not differing from individuals with ID ($p = 0.13$). The combined ASD and ID groups showed superior recognition of

Table 1
Participant characteristics of each group.

		N	Male/female	Mean age	Original CRT score	GARS-2 (cutoff = 85)
ASD		24	17/7	20.71 (3.86)	22.35 (9.00)	95.96 (15.53)
TD		28	21/7	20.64 (3.29)	67.14 (5.28)	62.32 (12.96)
ID		26	19/7	23.00 (3.07)	22.04 (8.84)	55.08 (11.38)
Difference (*t* test)	ASD vs. TD	N/A	N/A	0.07	−21.07***	8.52***
	ASD vs. ID	N/A	N/A	−2.33*	0.12	10.68***
	ID vs. TD	N/A	N/A	2.72**	−22.54***	−2.18*

Note. Standard deviations are shown in parentheses. CRT = Combined Raven Test; GARS-2 = Gilliam Autism Rating Scale – Second Edition.
* $P < .05$.
** $P < .01$.
*** $P < .001$.

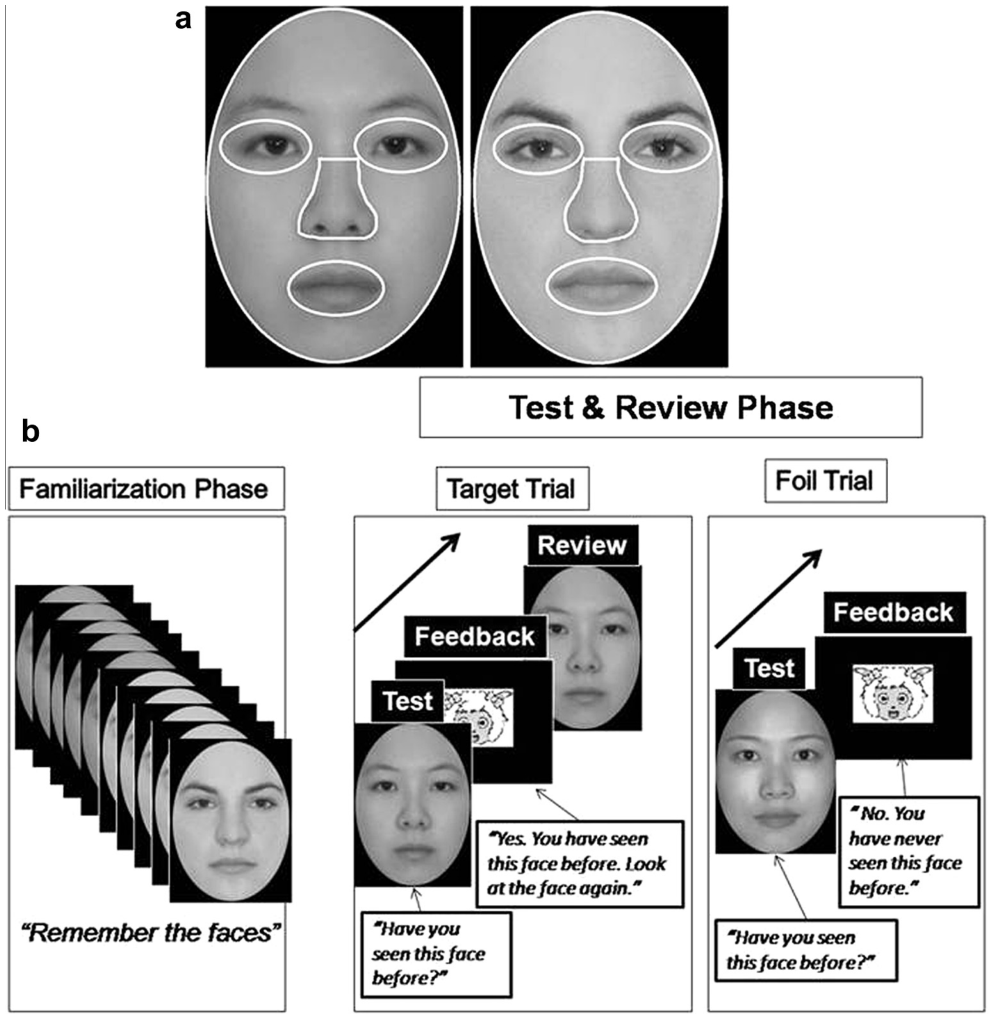

Fig. 1. Samples of face stimuli used in the task with area of interest (AOI) plots (a) and schematic representation of the experimental design (b).

Chinese faces compared to Caucasian faces ($p = 0.036$), whereas the TD group recognized Caucasian faces as well as Chinese faces ($p = 0.160$).

3.2. Fixation duration

Means and *SD*s of total face fixation duration (calculated by summing all fixation durations in a face), and proportional AOI fixation duration (i.e., eye, nose, and mouth regions) were listed in Table 2. We conducted 3 (Group: ASD vs. ID vs. TD) × 2 (Race: own vs. other) mixed-design ANOVAs to test the effects of group and race on total and proportional fixation durations, respectively. Results indicated a significant effect of race on total fixation duration on the face ($F(1, 75) = 8.93$, $p = 0.004$, $\eta^2 = 0.11$); that is, participants looked longer at Caucasian faces than Chinese faces. The 3 (Group) × 2 (Race) ANOVA was also performed to compare the total number of fixations on the whole face between groups and conditions, and indicated a significant main effect of group ($F(1, 75) = 5.24$, $p = 0.007$, $\eta^2 = 0.23$). As suggested by a priori contrasts, TD individuals fixated on the faces more than individuals with ASD ($p = .004$) and ID ($p = .014$). There was additionally a significant effect of participant group on fixation duration on the non-face areas ($F(2, 75) = 13.29$, $p < 0.001$, $\eta^2 = 0.26$). More specifically, the ASD group looked longer at the non-face areas than the TD group ($p < 0.001$), but not differently from the ID group ($p = 0.32$).

For the proportional fixation duration on the right eye, we found a significant main effect of race ($F(1, 75) = 33.56$, $p < 0.001$, $\eta^2 = 0.31$), a main effect of group ($F(2, 75) = 7.65$, $p = 0.001$, $\eta^2 = 0.17$), and a group × race interaction ($F(2, 75) = 9.27$, $p < 0.001$, $\eta^2 = 0.20$). More specifically, the ASD group looked less at the right eye than the TD group ($p < 0.001$), but not differently from the ID group ($p = 0.068$). Simple effect analyses showed that the ASD and TD groups looked longer at the right eye of Caucasian faces than of Chinese faces ($F(1, 75) = 5.21$, $p = 0.025$; $F(1, 75) = 48.34$, $p < 0.001$), but looking time at the right eye was similar for both races for the ID group ($F(1, 75) = 0.96$, $p = 0.33$). For the proportional fixation duration on the left eye, there was only a race effect ($F(1, 75) = 18.29$, $p < 0.001$, $\eta^2 = 0.20$), in which all groups spent more looking time on the left eye of Caucasian faces than on Chinese faces.

When both eyes were combined, we found a significant race effect ($F(1, 75) = 39.44$, $p < 0.001$, $\eta^2 = 0.35$), a group effect ($F(2, 75) = 4.88$, $p = 0.010$, $\eta^2 = 0.12$), and a group × race interaction ($F(2, 75) = 7.22$, $p = 0.001$, $\eta^2 = 0.16$). A priori contrasts revealed that individuals with ASD looked shorter to the eye region compared to TD individuals ($p = 0.003$), but not differently from individuals with ID ($p = 0.23$). Simple effect analysis showed that the ASD and TD groups looked longer at Caucasian eyes than Chinese eyes ($F(1, 75) = 5.56$, $p = 0.021$; $F(1, 75) = 47.63$, $p < 0.001$), while this difference was not significant for individuals with ID ($F(1, 75) = 3.22$, $p = 0.077$).

Table 2
Means and standard deviations of accuracy, and total and proportional fixation duration, by group and race.

		ASD		TD		ID	
		Own-race	Other-race	Own-race	Other-race	Own-race	Other-race
Behavioral performance	Accuracy (%)	52.53 (5.43)	49.86 (6.11)	81.11 (9.24)	82.98 (7.01)	55.29 (10.33)	52.59 (5.70)
Total fixation duration (ms)	Whole face	1804.79 (573.15)	1831.91 (658.52)	1931.20 (396.46)	2040.89 (373.02)	1841.78 (648.44)	1878.97 (683.79)
	Non-face areas	544.07 (483.74)	525.94 (451.93)	49.34 (20.49)	26.19 (19.85)	436.56 (443.37)	422.25 (489.01)
Proportional fixation duration	Right eye	.07 (.08)	.08 (.08)	.16 (.10)	.20 (.11)	.12 (.11)	.13 (.11)
	Left eye	.09 (.12)	.09 (.12)	.13 (.10)	.15 (.10)	.10 (.12)	.11 (.12)
	Nose	.36 (.20)	.34 (.20)	.30 (.14)	.25 (.13)	.20 (.15)	.20 (.15)
	Mouth	.11 (.09)	.10 (.10)	.10 (.07)	.09 (.07)	.08 (.09)	.07 (.07)

Note. Standard deviations are shown in parentheses.

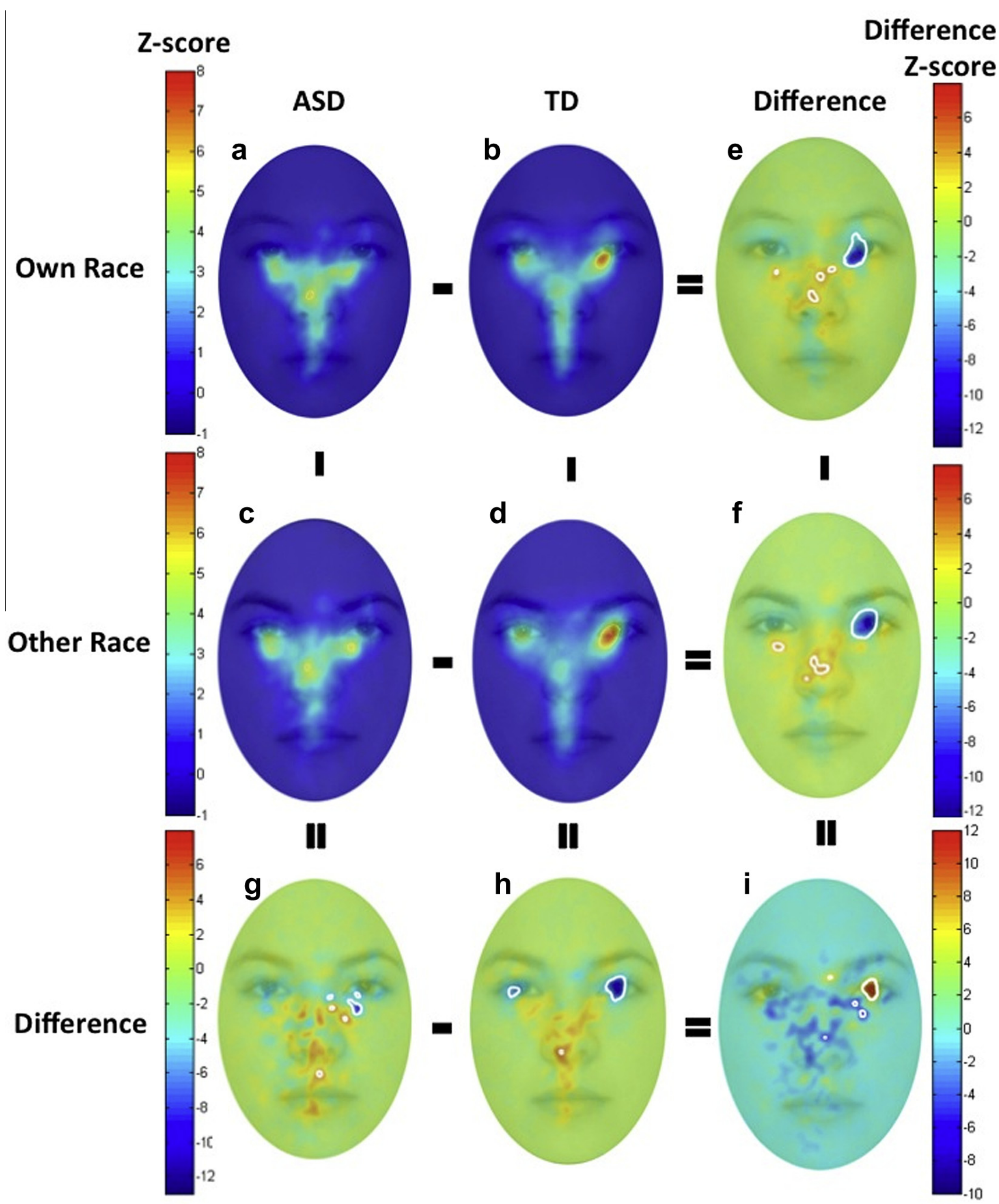

Fig. 2. Heat maps for ASD and TD groups viewing own-race faces (a and b), other-race faces (c and d), and the difference map (e–i). The colors represent *Z* scores of fixation durations, with warm colors standing for longer fixation durations and cold colors for shorter fixation durations. Regions of significant difference are marked by the white contours in the difference maps (at the alpha level of 0.05, two-tailed). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

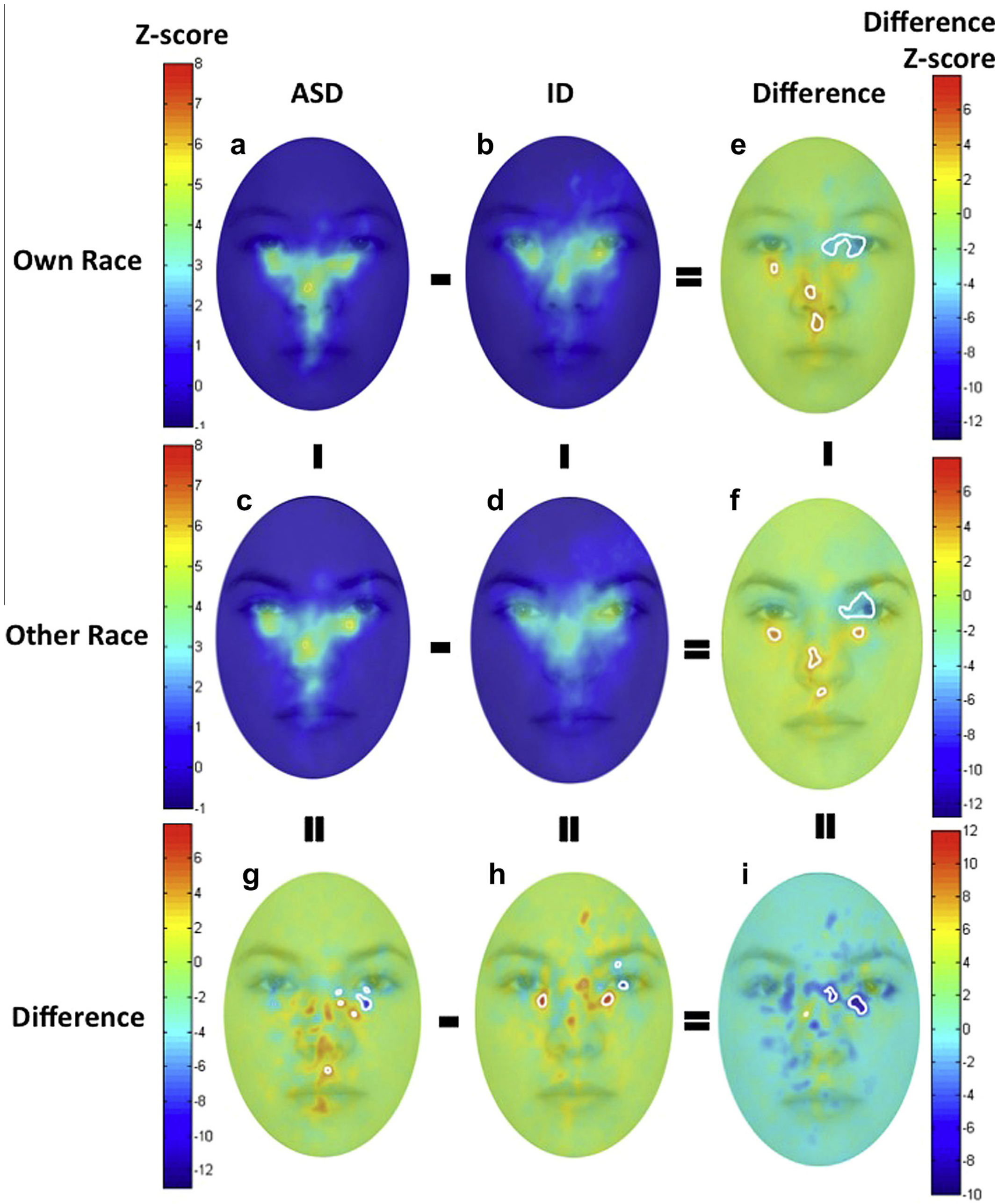

Fig. 3. Heat maps for ASD and ID groups viewing own-race faces (a and b), other-race faces (c and d), and the difference map (e–i). The colors represent Z scores of fixation durations, with warm colors standing for longer fixation durations and cold colors for shorter fixation durations. Regions of significant difference are marked by the white contours in the difference maps (at the alpha level of 0.05, two-tailed). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

For the proportional fixation duration on the nose, there was a significant race effect ($F(1,75) = 24.32$, $p < 0.001$, $\eta^2 = 0.25$) and a group effect ($F(2, 75) = 5.08$, $p = 0.009$, $\eta^2 = 0.12$). More specifically, the ASD group fixated the nose longer than the ID group ($p = 0.002$), but did not differ from the TD group ($p = 0.09$). There was also a group × race interaction ($F(2, 75) = 9.85$, $p < 0.001$, $\eta^2 = 0.21$). Simple effect analyses revealed that the ASD and TD groups fixated longer on the nose of Chinese faces than Caucasian ones ($F(1, 75) = 6.43$, $p = 0.013$, $F(1, 75) = 39.17$, $p < 0.001$), but individuals with ID spent a similar amount of time on the nose of both races of faces ($F(1, 75) = 0.01$, $p = 0.91$). Only a race effect on the proportional fixation duration on the mouth was found ($F(1, 75) = 6.91$, $p = 0.010$, $\eta^2 = 0.08$): all groups looked at the mouth of Chinese faces longer than that of Caucasian faces.

Fig. 2a–i shows the heat maps generated by the *i*Map. The heat maps displayed fixation distributions of the TD and ASD individuals during viewing of Chinese and Caucasian faces (Fig. 2a–d) as well as their differences (Fig. 2e, f, g, h, and i). The Z scores of fixation durations were represented by the colors. White contours on the maps indicated any area that was significantly different between groups and face race conditions ($p < 0.05$, corrected). As revealed in Fig. 2, both the ASD and TD groups fixated less on the eye region, and more on the central region (area directly below the eye region and on the nose) for Chinese faces than Caucasian ones. For both races of faces, the TD group fixated longer at the right eye area and shorter at the central area than the ASD group.

Fig. 3a–i shows the heat maps of the ASD and ID groups' scanning patterns for Chinese and Caucasian faces (Fig. 3a–d) as well as their differences (Fig. 3e, f, g, h, and i). Individuals with ID fixated less on the right eye region, and more on the region directly below the eyes for Chinese faces than for Caucasian faces. Also, for both races of faces, compared to the ID group, the ASD group looked shorter on the right eye area, and longer on the area below the eye area and the nose.

3.3. Correlations between recognition accuracy and eye movements

Behavioral performance (accuracy) of participants was correlated with eye-tracking indices using the Pearson correlation coefficient. Only participants whose recognition accuracies were above chance level (50%) were included in this analysis ($n = 62$). As is shown in Fig. 4, there was a positive correlation between the accuracy of face recognition and the number of fixations on the face ($r = 0.38$, $p < .001$) and proportional fixation duration on the right eye ($r = 0.36$, $p < .001$). Also, a negative correlation was found between accuracy and total fixation duration on the non-face areas ($r = -0.44$, $p < .001$). Other eye movement indices were not significantly correlated with recognition accuracy.

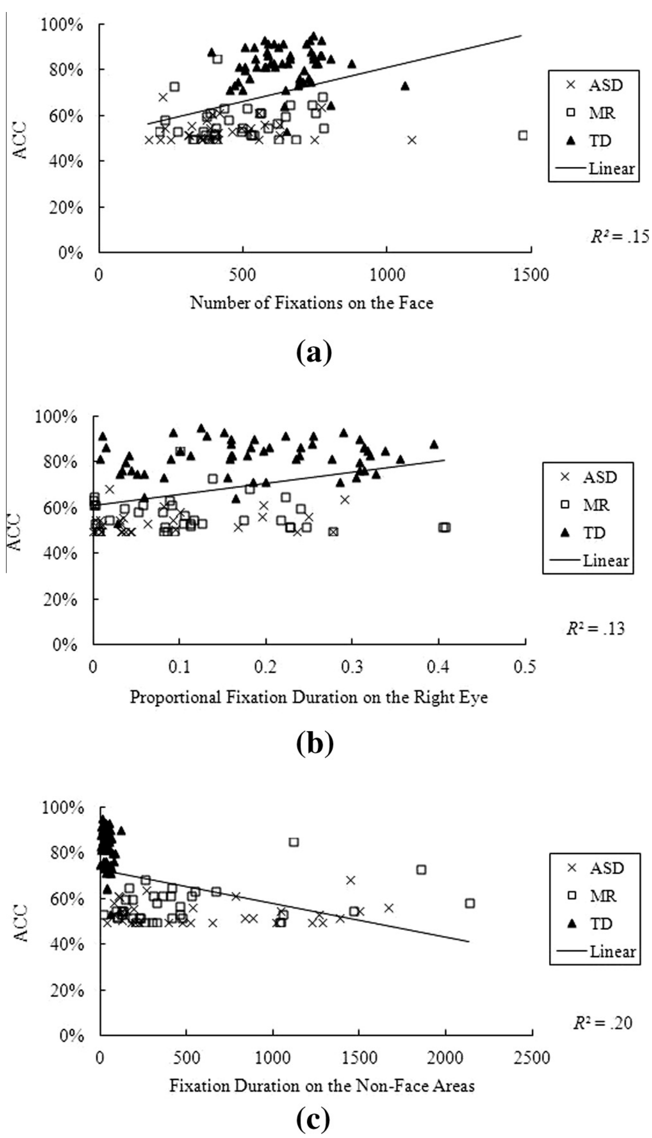

Fig. 4. Correlations of face recognition accuracy (ACC) with the number of fixations on the face (a), the proportional fixation duration on the right eye (b), and the total fixation duration on the non-face areas (c).

4. Discussion

The present study investigated whether individuals with ASD process other-race faces differently from own-race faces. We used eye-tracking to examine how ASD, as well as TD and ID groups, scan facial features of Chinese and Caucasian faces. Such an inquiry into the processing of faces from other racial groups in ASD should help to better specify the nature of the face processing abnormalities in ASD. In particular, it should help to determine whether there is a pervasive face processing deficit associated with ASD or whether there are some aspects of face processing spared in ASD.

Although individuals with ASD showed specific face scanning patterns compared to non-ASD individuals generally, they also displayed different eye movement patterns between Chinese and Caucasian faces. In accord with previous findings by Fu et al. (2012), the AOI and data-driven analyses revealed that TD individuals looked more at the eyes of Caucasian faces, and the nose and mouth of Chinese faces. Such differentiation was similar to that observed in the TD and ID groups. This nose-centric strategy, as argued in prior studies (Fu et al., 2012), is an adaptation to Chinese culture, which discourages excessive direct eye contact with other people. More crucially, individuals with ASD displayed the same type of differentiated cross-racial face scanning patterns as did TD individuals, suggesting that Chinese children with ASD, like TD children, were responsive to the enculturation of Chinese mutual gaze norms.

Results from the AOI analysis and the data-driven approach also showed some ASD-specific face scanning patterns: participants with ASD spent less time on the eye region compared with non-ASD participants. These results are consistent with the general finding of reduced visual attention towards the major face features, especially the eyes, in ASD (Falck-Ytter & von Hofsten, 2011). This “eye avoidance” tendency in individuals with ASD, according to Tanaka and Sung (2013), is an adaptive and compensatory perceptual strategy that protects individuals with ASD from social threat and discomfort caused by direct eye contact. The eye looking time in the study and test phases of the current study was correlated with recognition accuracy, suggesting that fixation on the eyes is important for face recognition. This finding offers a possible explanation for the face recognition deficit in ASD. However, it should be acknowledged that Wilson, Palermo, and Brock (2012) did not observe a relation between recognition accuracy and looking time on the eyes in their TD and ASD groups, and in our study, accuracy was correlated only with looking time on the right eye, but not the left eye. Other explanations for the face recognition deficits in ASD could be their reduced interest in human faces, as indicated by the correlation between recognition accuracy and the overall fewer number of fixations on the face combined with longer looking time on non-face areas.

The present study also measured recognition accuracy to determine whether the ASD, ID, and TD groups displayed superior recognition for own-race faces over other-race ones. Individuals with ASD and ID showed superior recognition of Chinese faces over Caucasian faces, consistent with the finding of the ASD group of Wilson et al. (2011). However, TD individuals performed well above chance and were not affected by face race, which may be due to the stimuli. The face pictures in the current study were all black-and-white, carefully balanced in overall brightness and luminance, and cropped to control for the impact of hairstyle and contour. These careful manipulations may make Chinese and Caucasian faces look more similar than in other studies without such manipulations. Also, the study faces were presented for a relatively long time (3 s) in order to collect rich eye tracking data, which may attenuate the effect of face race on recognition. A study using similar stimuli and a comparable stimulus presentation duration (Hu et al., 2014) also did not find the behavioral ORE in both typical children and adults.

Our finding of a behavioral ORE in ASD differs from that of Chien et al. (2014) which found no ORE in ASD. Several factors may contribute to this difference in outcomes: (a) Chien et al. (2014) used African faces as the other-race faces while we used Caucasian faces; (b) they used a two-alternative-forced-choice discrimination paradigm and we used a face recognition paradigm; (c) their participants were 6–10 year olds and ours were 15–25 year olds.

The findings of cross-racial differentiation in the face recognition and face scanning patterns in individuals with ASD fail to support the view that individuals with ASD suffer from an all-encompassing face processing deficit that mutes sensitivity to all aspects of experience. Rather, the finding that individuals with ASD display an other-race effect in both behavioral performance and scanning patterns as typically developing individuals do in other paradigms, supports the idea that individuals with ASD are (1) sensitive to cross-racial differences in face experience and (2) process face race information normally. Indeed, both the eye-tracking and behavioral results are in accord with the suggestion that while individuals with ASD may show theory of mind related deficits (e.g., Baron-Cohen, Leslie, & Frith, 1985), they may process social category information (i.e., race, gender) in ways that are similar to TD individuals (Hirschfeld, 2013; Hirschfeld et al., 2007).

One limitation of the current study was that we only tested Chinese samples of ASD, ID, and TD individuals. The question thus arises as to whether the different cross-racial face scanning patterns found in Chinese individuals with ASD in the current study are limited to an Asian population (Blais et al., 2008). According to previous findings, Caucasians display the opposite effect: they tend to look at the eyes of both Caucasian and Asian faces (Blais et al., 2008). To obtain a more comprehensive understanding of cultural differences in processing of face race information, future research should address whether individuals with ASD from different cultures (e.g., Caucasians from Europe or North America) also display a similar other-race effect as their Asian counterparts. In addition, as discussed above, participants with ASD may show divergent face scanning patterns in various stimuli and tasks. The face stimuli could be expanded to include more than Chinese and Caucasian faces, and the different types of tasks may include, for example, passive viewing of faces or categorization of the race of faces in addition to identification of faces.

5. Conclusions

In conclusion, the current study for the first time examined whether individuals with ASD display different cross-racial face scanning patterns. We observed cross-racial differentiation in visual fixation patterns for the ASD, TD, and ID groups. That is, all groups fixated longer on the eyes of Caucasian faces relative to Chinese faces, and shorter on the nose and mouth of Caucasian faces relative to Chinese faces. An ORE in behavioral performance in the face recognition task was also observed for the ASD and ID groups. Overall, the findings suggest that individuals with ASD process face race in ways that are similar to TD individuals, and like TD individuals, the face processing of individuals with ASD is influenced by differences in visual experience with different social categories.

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